SILURIAN AND DEVONIAN LIMESTONES OF WESTERN TENNESSEE.

(*Concluded from p. 583.*)

C. DEVONIAN STRATA IN THE TENNESSEE RIVER VALLEY.

11. *The Linden bed; Perryville, Linden, Horse Creek, Pyburn Bluff, White Sulphur Spring.*—About half a mile northeast of the railroad station at Perryville, a large quarry has been opened into the top of the Brownsport bed. Immediately above is found the base of the Linden limestone, with *Orthothetes woolworthanus*, *Rhipidomella oblata*, and *Striatopora issa*. The lower third of the Linden bed, 10½ feet thick, consists of fairly solid crinoidal rock with comparatively few fossils. The middle third, 11½ feet thick, is richly fossiliferous. It consists of softer rock, partly crinoidal, partly fine-grained, and more or less interbedded with clay. At the base of this middle division, *Stropheodonto beckei*, *Strophonella punctulifera*, and *Orthothetes woolworthanus* are common. *Dalmanites micrurus* is not rare, but *Uncinulus schucherti* is very scarce. Above this *Stropheodonta beckei* horizon the limestones and especially the more weathered beds and clays are full of the smaller brachiopods identified from the Linden bed at Perryville. The upper third of the Linden bed, about 15 feet thick, consists of fossiliferous clay. It is exposed in the northwestern corner of the town, and is overlaid by thin layers of limestone, full of bryozoans, forming a section 1½ feet thick, followed by a sandy bed which may be the Hardin sandstone. The Camden chert fossils found at Perryville occurred loose, and were apparently derived from the iron-ore gravels of Safford.

A mile north of Linden, above the spring north of the home of William H. Patton, the Brownsport bed is overlaid by solid massive limestone, 5⅓ feet thick, containing few fossils; more shaly beds, 7⅔ feet thick, containing the characteristic Linden bed fauna; clayey beds, 6½ feet thick, not exposed; a total of 20 feet referred to the Linden bed. Above this occurs

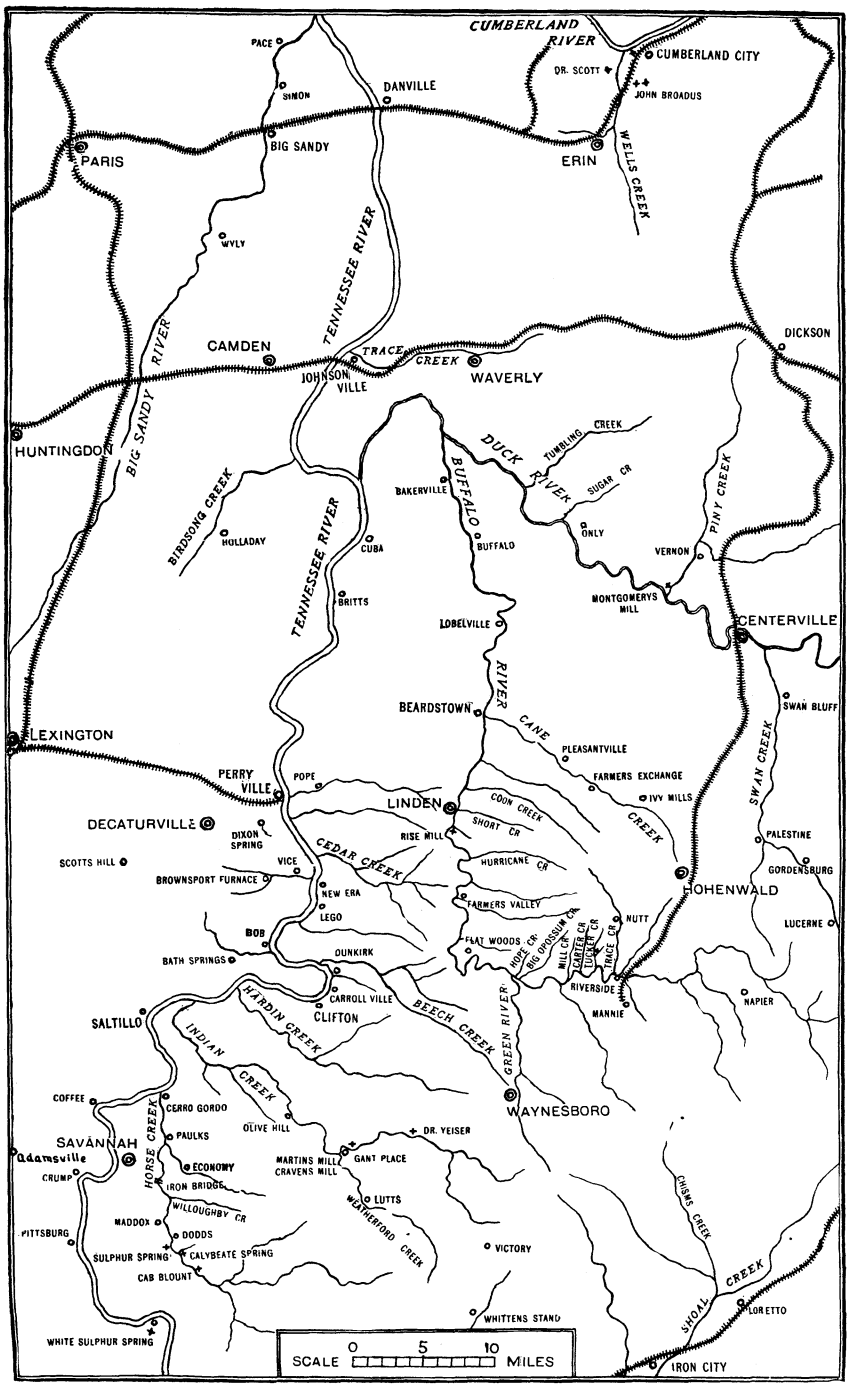

FIG. 7.—The Tennessee River basin.

(The name *Dunkirk* on the map should be read *Glenkirk*).

the Hardin sandstone, 1 foot thick, and the Black shale, 6½ feet thick. The fossiliferous part of the Linden bed is well exposed also about half a mile northeast of this locality, in the woods.

The Linden bed is exposed also on the eastern edge of Linden, below the level of the town spring at the foot of the hill, and thence eastward along the upper edge of the low bluff bordering the stream flowing from the spring toward the Buffalo River. The thickness of the Linden bed at this point is about 11 feet. Overlying it is a more massive rock, 2 feet thick, referred to the Camden chert; followed by the Hardin sandstone, 18 inches thick, and the Black shale, 6 feet thick, with numerous phosphatic nodules at the top.

About a mile east of Linden, on Short Creek, a quarter of a mile west of the home of J. S. Journey, the Linden bed is 11 feet thick. It is overlaid by the Hardin sandstone, 2 feet thick, followed by the Black shale.

The Linden limestone evidently thins out rapidly eastward. Half a mile east of the exposure west of the home of J. S. Journey, at the top of a bluff rising above a spring along Short Creek, east of the mouth of Jacks Branch, the Brownsport bed is directly overlaid by the Hardin sandstone, 2 feet thick, Black shale, 2 feet thick, and bluish sandy rock, 3 inches thick. No Linden rock is found at the home of William Goodwin on Coon Creek, 2¼ miles northeast of Linden, or at the Webb or Rise mill, half a mile south of Linden. It evidently thins out also southward, since it is absent northeast of Lego, along a creek also known as Short Creek. It is absent along the upper part of the Buffalo River between Flat Woods and Riverside, and along the upper part of Indian Creek above Olive Hill.

From the limited evidence so far secured it appears that the eastern line of outcrop of the Linden bed passes between Linden and the Rise mill, and then turns westward, crossing the Tennessee River somewhere north of Lego. There is no evidence of the presence of the Linden bed in the area between Brownsport Furnace and Bath Springs. It is possible that the eastern line of outcrop does not recross the Tennessee River north of the mouth of Horse Creek. The Linden bed is absent along

the Headwaters of Indian Creek. but is present along the headwaters of Horse Creek. The chief difficulty encountered in attempting to trace the eastern line of outcrop of the Linden bed is the absence of exposures at the proper horizon in most of the territory contiguous to the Tennessee River, due to removal of the upper part of the Silurian section and of the overlying

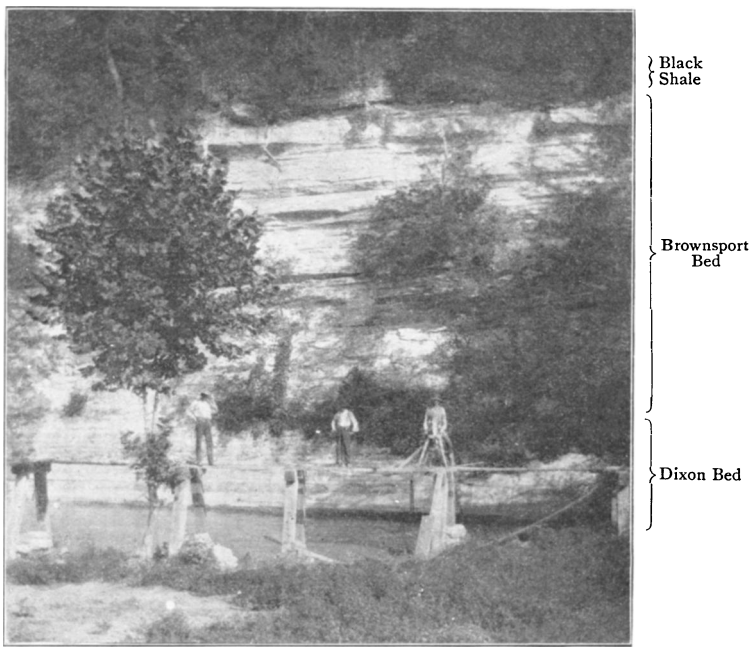

FIG. 8.—Bluff at Rise Mill.

paleozoic rocks by Cretaceous and Tertiary erosion. At most localities within this territory the Silurian rocks are directly overlaid by the Coffee sand or by the iron bearing gravels of Professor Safford.

The Linden limestone is well exposed at the Calybeate Spring on Horse Creek. Over a mile south of Maddox store, a road leaves the Florence road and passes through the woods eastward to the Sulphur Spring. Skirting the northern side of a large corn field, it crosses Horse Creek and follows the eastern bank for more than a mile, during the latter part of the distance along

the upper edge of a low bluff, ending at a cultivated field at the mouth of a stream traversing a narrow valley. The base of the bluff on the east side of Horse Creek, just north of the mouth of this stream, is formed by crinoidal, massive limestone, apparently belonging to the top of the Brownsport bed. Immediately above is limestone and clayey rock containing, within 10 feet of the base, *Camarocrinus* and a number of brachiopods belonging to the Linden bed fauna. Among these are *Dalmanella subcarinata*, two forms, one coarsely and one finely striate, *Rhipidomella oblata*, *Bilobites varica*, *Strophonella punctulifera*, and *Spirifer perlamellosus*. About 200 yards south of the locality just described, on the same side of Horse Creek, is the Calybeate Spring. Here the exposure of the Linden bed is at least 60 feet thick. Specimens of *Camarocrinus* are abundant in the lower and middle part. Two miles above the Calybeate Spring, in a gulley southeast of the home of Cab Blount, on the east side of a branch of Horse Creek, the Linden bed is overlaid by a trace of Black shale, poorly exposed, followed by the Waverly. Within 10 feet of the top of the Linden bed it contains specimens of *Camarocrinus*.

Large exposures of the Linden bed line the northern side of the Tennessee River for more than a mile east of Pyburn Landing. Here was obtained the section described by Safford as occurring opposite White Sulphur Spring. At the eastern end of the exposures, west of the mouth of Bluff Creek, the exposure of the Linden bed is 101 feet thick. At the base of the section there is a series of cherty limestones, 11 feet thick, containing a species of *Chonostrophia* 23^{mm} wide related to *Ch. helderbergia*, *Rhipidomella oblata*, *Uncinulus nucleolatus*, *Uncinulus* (*Wilsonia?*) *schucherti*, *Meristella meeki*, and *Dalmanites pleuroptyx*. Unequal erosion of the cherty limestone forming the Linden bed has caused the formation of shelves at elevations of 11, 34, and 50 feet above the river. *Camarocrinus* occurs from the water's edge up to the 50 foot level. At the top of this part of the section, *Camarocrinus* is associated with *Favosites conicus*, *Favosites* with a convex base covered by the epitheca, *Pleurodictyum lenticulare*, *Rhipidomella oblata*, *Orthothetes woolworthanus*, *Leptaena*

rhomboidalis, *Stropheodonta beckei*, *Strophonella punctulifera*, *Uncinulus nucleolatus*, *Atrypa reticularis*, *Delthyris perlamellosus*, *Delthyris* related to *D. perlamellosus*, but with a large, high, flat, triangular area on the ventral valve, *Spirifer cyclopterus*, *Spirifer* with 3 or 4 plications on either side of the mesial fold, ornamented with fine radiating striae, evidently closely related to or identical with *Spirifer tenuistriatus*, *Meristella meeki*, *Platyceras tenuiliratum*, and *Dalmanites pleuroptyx*.

No specimens of *Camarocrinus* were found above the 50-foot level, but the Linden fauna continues into the overlying rocks. It is abundantly represented in two cherty layers which immediately overlie the *Camarocrinus* beds, and in a layer of chert, about 1 foot thick, which occurs about 19 feet above the *Camarocrinus* beds. A large part of the section above the *Camarocrinus* horizon is soft and weathers readily, usually forming poor exposures, but the top of the Linden section at this locality is formed by more massive limestone, 17 feet thick, containing few fossils. Among these is *Dalmanites pleuroptyx*. The Black shale series is absent. The basal layer of the Waverly is 20 inches thick, and consists of sandy shaly rock belonging to the Hardin sandstone, and containing large specimens of *Spirophyton*.

The Linden bed dips westward; that part of the bed exposed in the eastern bluff apparently dips beneath the rock forming the western bluff, west of Anderson and Johnson branches. A study of the western bluff, however, suggests that the section here exposed is merely a repetition of the eastern section, just described. The massive limestone at the top of the Linden bed, however, has a thickness of only 6 to 10 feet, being unconformably overlaid by the Black shale series. It contains *Rhipidomella oblata*, *Spirifer cyclopterus*, *Uncinulus nucleolatus*, *Meristella princeps*, *Platyceras tenuiliratum*, *Dalmanites pleuroptyx*, and *Phacops logani*.

West of the store at White Sulphur Spring, 1 ½ miles southwest of Pickwick Landing, numerous Linden bed fossils occur in the residual chert along the middle and lower parts of the hillside. Exposures occur also in the vicinity of Decaturville, at Hollady, 5 miles south of Big Sandy station on the Lower Cam-

den road, and at other points along the Big Sandy River. The Linden bed is exposed along the Cumberland River, a mile west of Cumberland City, and on the eastern side of the railroad, a quarter of a mile south of the home of John Broadus. Owing to faulting, it is impossible to determine the thickness of the Linden bed in the Wells Creek basin, but, as far as may be judged from the exposures seen, it does not exceed 30 feet. East of the home of John Broadus the exposure of the Linden bed does not exceed 10 or 15 feet. Mr. Charles Schuchert found three specimens of *Camarocrinus* in Benton county at an undetermined horizon.

As far as may be judged from the few sections so far studied, *Camarocrinus* is abundant in the lower half of the Linden bed, and is either much rarer or altogether absent in the upper half. The upper half, on the contrary, appears to contain a greater quantity of softer, clayey material, which weathers readily. It appears to give rise to the greater number of exposures at which the Linden bed fossils may be collected free from the rock. It appears possible to divide the Linden bed into two subdivisions, a lower, Camarocrinus or *Ross limestone*, and an upper, or *Pyburn limestone*. The exposures at Perryville, Linden, and Cumberland City appear to belong to the upper or Pyburn horizon. The upper bed appears to have a greater eastward extension than the lower, overlapping the latter. Very little attention has been given so far to the stratigraphy of the Devonian in western Tennessee. The chief results of the writer's efforts have been the conclusion that the Linden bed is absent in a large part of the territory east of the Tennessee River once believed to contain it. It is not known to occur anywhere between Rise mill, New Era, Bath Springs, Economy, and Martin's mill.

12. *The Camden chert.*—As in the case of the Linden bed, the thickest sections of the Camden chert are found at the more western points of outcrop. At Linden, on the eastern edge of the town, at the spring near the foot of the hill, it is represented by a massive gritty limestone, only 2 feet thick, immediately beneath the Hardin sandstone. In this rock were found two ventral valves of *Spirifer*, silicified, showing both the exterior and also the large muscular scars in the interior. They were identi-

fied by Schuchert as *Spirifer murchisoni*, a lower variety of *Spirifer arrectus*. They are evidently foreign to the Linden bed, and require the identification of the gritty limestone as part of the Camden chert series.

At Perryville, two silicified specimens of *Eatonia peculiaris*, and a single specimen of a large form of *Camarotoechia* (40^{mm} long, 36^{mm} wide, and 28^{mm} thick) belonging to the group of *Camarotoechia pleiopleura*, were obtained loose at the base of the sand and gravel overlying the Linden bed at the quarry. If the identification of the Hardin sandstone in the northwestern corner of Perryville is correct, the Camden chert bed can not exceed 2 or 3 feet at this locality, and it is probably altogether absent. It probably occurs, however, a short distance farther north. It is said, by Professor Safford, to occur in Decatur county, but it has not yet been recognized farther southward, in any part of Hardin county. The typical exposures occur at Camden, where the section is at least 60 feet thick. Five miles south of Big Sandy station, on the lower Camden road, the base of the Camden chert is said by Professor Safford to rest upon the Lower Helderberg. The writer has not seen any locality where it is possible to draw any sharp line between these formations. Lithologically, the formations are alike, and paleontologically, the change from the Linden bed fauna to the Camden chert fauna appears to be gradual rather than abrupt.

The chert derived from the Camden chert appears on the hillsides for several miles south of Big Sandy station. At the old Williams mill site, 5 miles above the mouth of Big Sandy station, there is a large exposure of the Camden chert bed. The thickness of the bed must be considerably in excess of 50 feet.

About 4 miles north of Bakerville, at the Whirl in the Buffalo River, the top of the Camden chert rises nearly 50 feet above the river. The exposure may be reached most conveniently by turning off from the Waverly road at the home of Clinton Burcham, following the lane along the northern edge of the hill for half a mile to the home of Henry McClure, and then crossing the field southeastward to the river bluff. The upper layers contain *Eatonia peculiaris*, *Amphigenia curta*, *Anoplotheca flabellites*, and a

Rhipidomella resembling *Rhipidomella oblata.* Two species of *Spirifer* occur which are related apparently to *Spirifer unicus* and *Spirifer arrectus.* The typical Upper Oriskany, characteristic of the Oriskany sandstone of the Appalachian region, does not occur, but a part of the Camden chert appears to belong to a higher horizon at least than at first supposed. A single specimen of *Edriocrinus* was found.

The same species of *Edriocrinus* occurs near the western end of the exposures along the Cumberland River, west of Cumberland City; on the eastern side of the railroad, a quarter of a mile south of the home of John Broadus; and on the rocky face of the hill southeast of the home of Christopher Schmidt, about a mile south of the home of Dr. Scott. At the western end of the exposures along the Cumberland River Professor Safford identified the top of the limestone section as belonging to the Camden horizon. The writer was not able to verify this in the short time at his command. No specimens of the species of *Edriocrinus* in question were found in the undoubted Linden bed exposures farther southward, but the genus is known to occur also in the Helderbergian elsewhere, although the species in question may have a more limited range.

13. *The Onondaga limestone.*—On the western flank of the Cincinnati geanticline, along the Harpeth River, between Newsom and the bridge west of Pegram, the Silurian is directly overlaid by a thin bed of Devonian limestone,[1] varying in thickness from 12 feet at the west to 3 feet at the most eastern point of outcrop. West of Pegram, at the bridge, it rests upon the soft clay forming the lowest part of the Brownsport bed. At Newsom, at the most eastern point of outcrop, it is underlaid by the equivalent of the Lego bed, 32 feet thick. *Nucleocrinus* (*Olivanites*) *verneuili*, is a characteristic species. *Stropheodonta demissa*, *Stropheodonta perplana* *Rhipidomella penelope*, and *Nucleospira concinna* are also found. This white and comparatively pure limestone is overlaid by a darker and more sandy limestone containing small grains or concretions of some black substance, similar to the black particles found

[1] Silurian and Devonian limestones of Tennessee and Kentucky, *Bull. Geol. Soc. Amer.*, Vol. XII, 1901.

in the beds containing fish-teeth in the Devonian of Kentucky and Indiana.

At the Whirl, 4 miles north of Bakerville, at the west end of the bluff exposing the Camden bed, there is a cultivated field. Almost directly east of the well and stable in the center of this field, near the lower part of the hillside, Devonian corals are very abundant. Species of *Heliophyllum*, and *Blothrophyllum* occur which closely resemble forms occurring in the Corniferous at the Falls of the Ohio River, at Louisville, Ky. Various species of *Cystiphyllum*, *Cyathophyllum*, and *Cladopora* also are found. In addition to a very large form of *Atrypa reticularis*, a single specimen of *Reticularia fimbriata* was present. The corals have been loosened by residual decay from a bed of limestone, about 3 feet thick. The top of this layer is formed by a darker, sandy layer, varying from a mere film to a little over 2 inches in thickness. This darker part resembles the darker layer at the top of the Devonian limestone section at the bridge west of Pegram. It contained a single, pointed fish bone, 45^{mm} long. This bed of limestone, 3 feet thick, is believed to be of about the same age as the Devonian limestone at Pegram. Both limestones are correlated with the Jeffersonville limestone of Kentucky and Indiana, which is the equivalent of the Corniferous or Onondaga limestone of more eastern sections.

The occurrence of the Onondaga limestone near Bakerville suggests that it may be expected at other localities in western Tennessee northwest of a line passing from Bakerville to Lexington.

14. *The Devonian Black shale series.*—The Chattanooga Black shale decreases in thickness from the north central part of the state southward and westward. Its thickness in the neighborhood of Cumberland City cannot be determined with accuracy, but it appears to reach at least 10 feet. At Montgomery's mill the shale has a thickness of 6 feet 3 inches; at Centreville, of 4 feet 6 inches; at Dean's quarry, of 2 feet. In the neighborhood of Linden the thickness varies between 1 and 6½ feet; at several exposures east of Linden a thin layer of sandy rock occurs in the shale, about 1 foot above its base. Along the Buffalo River it is

usually absent; one exposure, 1 foot thick, occurs on Tucker branch, and another, 2 feet thick, several miles west of the mouth of Green River. A trace of Black shale, not well exposed, was seen in a gully on the west side of Horse Creek, southeast of the home of Cab Blount. It is absent at Pyburn Bluff, opposite White Sulphur Spring. Five miles southwest of Mount Pleasant, at the Big Hill on the road to Waynesboro, the Black slate is absent, but a mile southeast of the hill it attains a thickness of 2 feet. At Dodson station and at Lynnville, 15 miles southeast of Mount Pleasant, it does not exceed 15 inches. At Iron City it varies from 6 inches to nothing.

From these and many other observations it may be seen that the Black shale is either very thin or is entirely absent in the southern parts of Maury, Lewis, and Perry counties, and in all of Giles, Lawrence, Wayne, and Hardin counties.

The Black shale occurs also on the western side of the Tennessee River. It was struck in digging a well north of the landing at Saltillo. A considerable quantity of Black shale was struck northwest of the furnace at Brownsport Furnace. A small exposure occurs near the bottom of a broad valley along the road half-way between Dixon Spring and Perryville. It probably occurs at other localities farther north. The scarcity of exposures is probably chiefly due to removal by erosion during Cretaceous and Tertiary times, the sands and gravels of these ages resting directly on Helderbergian and Silurian rocks in a large part of the area so far investigated.

At the more northern exposures the Black shale is usually underlaid by a sandy rock, 1 or 2 feet thick, and overlaid by another layer, usually only several inches thick, characterized by the presence of phosphatic nodules. Southward the sandy layer becomes thicker, developing into the *Hardin sandstone*. Owing to the thinning out of the Black shale in this direction, the *nodule layer* not infrequently rests directly on the Hardin sandstone. This is shown at a number of exposures along the upper part of the Buffalo River, between Riverside and Flatwoods. Farther south the phosphatic nodule layer is also usually absent, so that in the southern counties the Hardin sand-

stone is often the only representative of the Black shale group. The most southern localities at which phosphatic nodules were observed were at W. D. Holton's home, 3½ miles northwest of Waynesboro, and at the Taylor quarry near Iron City.

The Hardin sandstone frequently attains a thickness of 7 to 8 feet. The greatest thickness observed was 11 feet. About a mile northwest of Martin's mill, on Indian Creek, a fish plate, 4 inches long, was observed imbedded in this sandstone. At several localities *Barroisella subspatulata* was seen in the more shaley layers immediately above the Hardin sandstone. These layers form a transition to the Waverly, the Lauderdale cherty beds of the Alabama Survey. The eastward extension of the Hardin sandstone has not yet been determined.

D. SILURIAN AND DEVONIAN STRATA OF THE WELLS CREEK BASIN.

The Wells Creek Valley, southwest of Cumberland City on the lower part of the Cumberland River in western Tennessee, is 53 miles distant from Baker station, and 45 miles from Whites Bend, Newsom, and Centreville. Both lithologically and faunally the Silurian of the Wells Creek valley presents the facies of the Silurian of the Tennessee River valley rather than the appearance of the Silurian exposed on the western flank of the Cincinnati anticline.

About 3 miles southwest of Cumberland City, in a railroad cut northwest of the home of John Broadus, there is a considerable exposure of Ordovician rock, probably equivalent to the Saltillo limestone, originally consisting of frequent alternations of clay and clayey limestone, but now badly decayed and reduced in large part to shaly material. Owing to a local, overturned fold, the Silurian base is found south of the Ordovician exposure and apparently dipping beneath it. The base of the Silurian section consists of hard limestone, much faulted, estimated to be 22 feet thick. The lower half is massive and contains *Favosites favosus*. The upper half contains cherty layers. Next in order of succession is a red, clayey rock, also faulted, estimated to be 14 feet thick. At its base it is more whitish. At the top it grades into limestone, 7 feet thick, less red and clayey above, containing

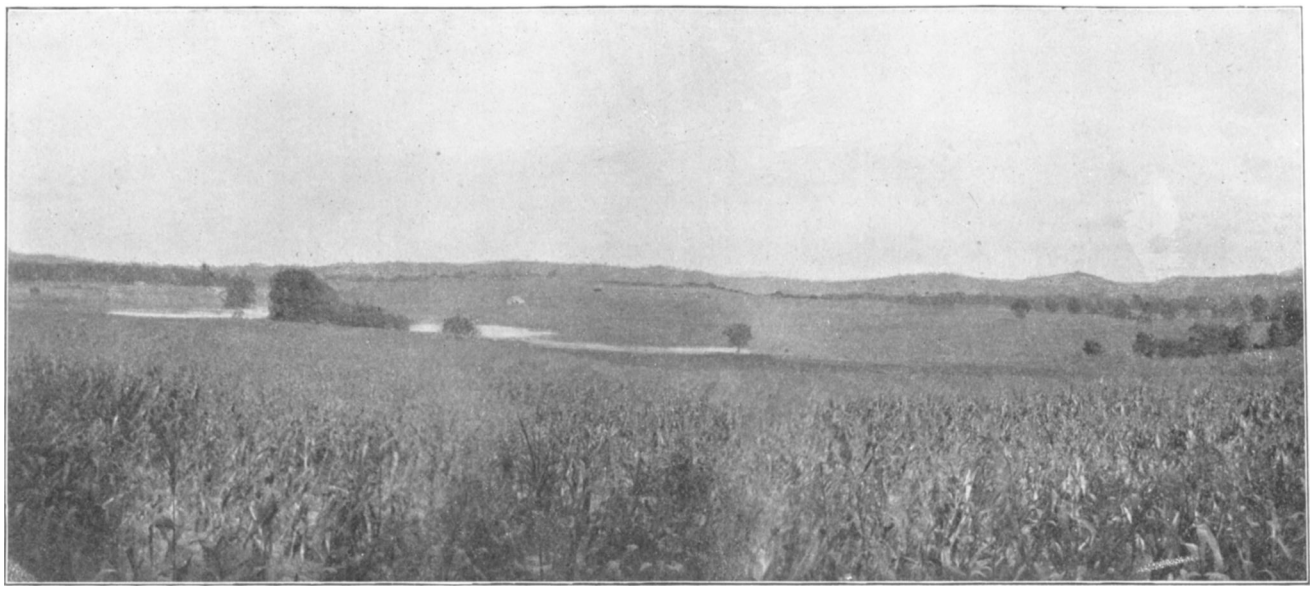

FIG. 9.—View from home of Dr. W. B. Scott, east across the Wells Creek basin, showing the dome structure. The central area is the region of the Wells limestone. The water in the foreground, due to recent heavy rains, and the line of trees circling from the right across the background, indicates in a general way the location of the Saltillo limestone. Along the foot of the hills bordering the basin, Silurian and Devonian rocks are exposed. The upper part of the hills and the surrounding country consists of sub-carboniferous rocks.

Stephanocrinus osgoodensis and *Pisocrinus gemmiformis*. The red clay and reddish limestone is the equivalent of the Osgood bed as identified at Clifton and elsewhere, and the white limestone at the base of the Silurian section corresponds to the Clinton.

Next in order of succession is slightly crinoidal limestone, 2 feet thick, followed by reddish clay, 3 feet thick. Stratigraphically above this horizon belongs the crackled white and reddish limestone, the equivalent of the Glenkirk bed. Owing to the failure to identify the Waldron bed, the subdivisions of the Glenkirk bed, the Laurel and Lego limestones, cannot be recognized. This difficulty is increased by a considerable amount of very irregular faulting. Along the road east of the home of John Broadus the top of the Glenkirk bed is well exposed. It is overlaid by dark, brick-red clay rock, 32 feet thick, belonging to the Dixon bed. This is followed by a section 20 feet thick, not exposed. The overlying Brownsport bed dips strongly eastward. If not faulted, the section is 170 feet thick, but faulting is not improbable. *Astraeospongia meniscus* occurs near the base. At the top of the section a thin layer of fossiliferous limestone belonging to the Linden bed, is exposed. In a gully, southeastward, Black slate is exposed.

Along the railroad, a quarter of a mile south of the home of John Broadus, there is a considerable exposure of limestone. A part of it contains *Edriocrinus*. At the southern end of the exposure is a richly fossiliferous layer, apparently belonging to the Linden bed.

In the field south of the home of Dr. Scott, the layers at the top of the Osgood bed, containing *Pisocrinus gemmiformis*, and *Stephanocrinus osgoodensis* are found. Along the road southwest of the house and in the cedar glade west of the same, brachiopods and sponges belonging to the Brownsport horizon occur. About a quarter of a mile north of the house, along the road following the base of the hill, the Glenkirk bed is well exposed. A part of the Glenkirk exposure consists of a very hard and fine-grained, massive, red limestone. Another part is softer and white, followed by the red clayey rock belonging to the Dixon bed, well exposed. The Linden bed was not identified at this

locality. About a mile southward, on a rocky hillside south of the home of Christopher Schmidt, *Edriocrinus* occurs in the limestone.

Along the Cumberland River, about a mile west of Cumberland City, a short distance beyond the exposures which line the bank, Black shale is exposed above the level of the road. At

FIG. 10.—Saltillo limestone, at crossing of pike from Cumberland City to Erin over the railroad.

the western end of the rock exposures along the bank, just below the level of the road, the Linden bed fossils are abundant. It is possible that some of the overlying limestones belong to the Camden chert horizon but the writer was not able to identify it in the short time at his disposal. The red rock forming the greater part of the exposures along the bank eastward toward Cumberland City appears lithologically to belong to the Glenkirk horizon. Faulting appears to be very frequent, bringing into contact all sorts of rocks, making stratigraphic work difficult. However, even a hasty examination of the field is sufficient to

determine the fact that in all essentials the Silurian and Devonian sections of the Wells Creek basin strongly resemble those of the Tennessee River valley.

E. THE EQUIVALENCE OF THE CLIFTON, LINDEN, AND CAMDEN LIMESTONES TO OTHER BEDS.

In the *Geology of Tennessee*, published in 1869, Professor Safford included all Niagaran strata, from the Clinton bed to the Brownsport bed, inclusive, in his *Meniscus limestone*. He recognized, however, two subdivisions, each about 100 feet thick, the lower called the *Variegated bed*, the upper called the *Sponge-bearing bed*. The Variegated bed included the Clinton, Osgood, Laurel, Waldron, and Dixon beds of the present paper. The Sponge-bearing bed included the Brownsport bed. *Astraeospongia meniscus* is confined to the upper or Sponge-bearing bed.

In the *Elementary Geology of Tennessee*, published in 1876, Safford and Killebrew proposed the name *Clifton limestone* for the Meniscus limestone. This name is, therefore, equivalent to the name "Niagaran" as now defined.

At Clifton, the type locality, the section along the river below the landing includes the Clinton, Osgood, and Laurel limestones. The section along the river about three-quarters of a mile above the landing includes the upper part of the Laurel bed, the Waldron, Lego, and Dixon beds, and the greater part of the Brownsport bed. Immediately in the rear of the town, on the hillside north of the Waynesboro road, the upper part of the Lego bed, all of the Dixon red clay, and the base of the Brownsport bed are exposed.

As a synonym for the Niagaran, the name "Clifton limestone" will be found useful.

In the *Geology of Tennessee*, all strata in western Tennessee intervening between the Clifton bed and the Chattanooga black shale were included in the Lower Helderberg. In 1876, in the *Elementary Geology*, Safford and Killebrew employed the name *Linden limestone* for these strata. In 1899 Safford and Shuchert published an article in the *American Journal of Science*, entitled "The Camden Chert of Tennessee and its Lower Oriskany

Fauna," in which the Oriskany age of the upper part of the beds hitherto included in the Linden bed was shown. Therefore, in 1900, in a second edition of the *Geology of Tennessee*, Safford and Killebrew restricted the use of the name "Linden limestone" so as to include only beds belonging to the Helderbergian as now defined, while the name "Camden chert" was given to the Oriskanian strata formerly included in the upper part of the Linden limestone. The Linden limestone as now defined appears most clearly equivalent to the Delthyris or New Scotland bed.

The Camden chert was placed by Schuchert in the lower part of the Oriskanian. He called attention particularly to the absence of the characteristic upper Oriskanian species: *Hipparionyx proximus*, *Chonostrophia complanata*, *Spirifer arenosus*, *Rensselaeria ovoides*, *Meristella lata*, *Camarotoechia pleiopleura*, *C. barrandei*, and *C. speciosus*. Since his paper appeared a specimen related to *C. pleiopleura* was found loose in the sand above the Linden bed at Perryville, and a *Spirifer* resembling *Spirifer unicus* was found in the top of the Camden bed at the Whirl in the Buffalo River north of Bakerville.

The use of the name "Linden limestone" for the Helderbergian section in Tennessee is unfortunate, since at the type locality, Linden, the Helderbergian does not exceed 17 feet in thickness, while the maximum thickness in the state exceeds 100 feet. Moreover, the Helderbergian at Linden is overlaid by a thin section of Camden chert, 2 feet thick, hitherto included in the Linden bed. The Linden bed at Linden apparently belongs to the upper, more clayey part of the Helderbergian section as exposed in Tennessee, overlying the *Camarocrinus* beds. However, too little attention has been given as yet to the stratigraphy of the Devonian limestones of Tennessee to warrant a definite conclusion.

F. THE COFFEE SAND.

At various localities along the Tennessee River, in Hardin county, the paleozoic formations are overlaid by yellowish sands, sometimes interstratified with beds of clay. They have been called the Coffee sand by Professor Safford, and are believed to be equivalent to the Tombigbee sand, referred to the Lower

Cretaceous. The exposure at Coffee Landing is typical for the Tennessee beds. Silicified trunks of trees are not uncommon. One, 6 feet long and 2 feet in diameter, occurred in the sand directly above the Glenkirk limestone at the Welch or Maddox mill on Horse Creek. Another was found near Lutts, beyond the post-office, on the road to Waterloo. The locality is called Pin Hook Hill, and lies between Rutherford and Horse Creeks. A third trunk is seen on the Jack Martin farm, about seven miles north of Cypress Inn and five miles south of Victory, on the headwaters of Weatherford fork of Indian Creek. The trunk is found in the hollow in the field below the Martin house. The locality is fully twenty miles east of the Tennessee River. It has been suggested that the Gulf of Mexico once extended much farther north than at present, reaching the southern part of Illinois and covering southeastern Missouri. If the Coffee sand was deposited off its shores, the Gulf, during early Cretaceous times, must have extended east of the Tennessee River, at least in the southern part of Tennessee, in parts of Wayne and Hardin counties.

G. THE IRON ORE GRAVELS.

In western Tennessee, in the area lying between the Great Central Basin and the Tennessee River, the paleozoic rocks are usually overlaid by a great mass of sands and gravels, often cemented by ferruginous material. Sometimes the ferruginous material is in sufficient quantity to prove valuable as an iron ore. Thirty-five furnaces were in operation before the war, and the ore is still mined at a number of localities. The branches of railroad from Dickson to Mannie, from Summertown to Napier, and from Iron City to Pinckney owe their existence to the presence, at their terminals and at various points along the line, of ferruginous gravels, sufficiently rich in iron ore to be mined. The large furnaces at Florence and Sheffield in Alabama partly depend upon this source. The ferruginous iron-ore gravels extend west of the Tennessee River for a distance of ten or fifteen miles, resting upon the paleozoic rocks on all the higher hills. At lower levels, where the paleozoic rocks are covered by the Coffee sand, the iron-ore gravels rest upon the Coffee sand.

Along Horse Creek, the Ordovician and Silurian rocks have been reduced by Cretaceous erosion to a sort of base level and then covered by the Coffee sand. The Helderbergian exposures at the Calybeate Springs appear to have risen above the level of the Coffee sand (Fig. 3, p. 579). No careful study of the Coffee sand or of the iron-ore gravels has yet been made in the area in question.

H. THE AGE OF THE CINCINNATI GEANTICLINE.

15. *As determined by observations in Tennessee.*—Along the Cincinnati geanticline in Tennessee the Chattanooga black shale rests unconformably on Silurian and Ordovician rocks. Along the crest of the geanticline, for a width of 55 to 75 miles, the Black shale, where not removed by subsequent erosion, rests upon Ordovician strata. On either side of this area it rests upon the Silurian. Along the eastern line of outcrop of the Silurian, on the western flank of the geanticline, the Black shale rests upon the Clinton. Farther westward, proceeding to points more distant from the broad crest of the geanticline, the Black shale rests successively upon the Osgood, Laurel, Waldron, and Louisville beds, the higher subdivisions of the Silurian. On proceeding still farther westward, into the basin of the Tennessee River, this unconformity continues, so that the Black shale rests upon higher Silurian rocks in the Tennessee River valley than at Pegram, Centreville, Riverside, or Iron City. It rests upon higher layers of the Brownsport bed along the Tennessee River than at the more eastern exposures of this bed. East of Linden the Black shale rests upon the attenuated edge of the Linden bed. At Linden it rests upon the still more attenuated edge of the Camden chert. West of the Tennessee River both the Linden and the Camden beds are represented by thicker sections.

The Tennessee River region may be regarded as having formed, in times preceding the deposition of the Black shale, a broad geosyncline of Silurian and Devonian limestones, lying west of a broad geanticline of Ordovician strata. The axis of the geosyncline lay a considerable distance west of the Tennessee River. Both lithologically and paleontologically the Silu-

rian deposits of the geosyncline differ sufficiently from those of the geanticline to form a distinct province. The Silurian deposits of the geosyncline extended northward into southern Illinois and the adjacent part of Missouri. The formation of this geosyncline was the first expression of the series of changes which finally resulted in the formation of the lower Mississippi valley.

Mesodevonic limestones are but scantily represented in the Tennessee River valley. At the Whirl in the Buffalo River, 4 miles north of Bakerville, they are 3 feet thick. Forty-five miles farther east, along the Harpeth River, they vary in thickness between 3 and 12 feet. At both localities, the Mesodevonic limestones belong to the Onondaga horizon. At Newsom, the Onondaga limestones rests on the equivalent of the Lego bed; at Pegram, on the lower part of the Brownsport bed; and north of Bakerville, on the Camden chert bed. The unconformity thus indicated suggests the existence of the Cincinnati geanticline in times preceding the Mesodevonic.

The Paleodevonic is absent along the western flank of the Cincinnati geanticline, in Tennessee, Kentucky, and southern Indiana. It is exposed, however, at numerous points in the Tennessee River valley, especially west of the Tennessee River. Both the Oriskanian and the Helderbergian are represented. Where more fully developed, the passage from the Helderbergian to the Oriskanian appears to be gradual, not indicating any unconformity between them. At their attenuated margins near Linden, the line of demarkation between the beds is very distinct. This suggests the growth of the Cincinnati geanticline during the Paleodevonic times.

Very few localities have so far been discovered where the contact between the Helderbergian and the Silurian may be studied. At all of these localities the Linden bed rests upon the Brownsport bed, and the change from the Silurian to the Devonian fauna is abrupt. It is impossible to determine at present whether the Linden bed rests upon higher horizons of the Brownsport bed westward than along the eastern line of outcrop. The faunus of the Brownsport have not yet been studied in sufficient detail to warrant any conclusions at present. If the

Linden bed fauna at Linden is the equivalent of the upper or Pyburn fauna at Pyburn Bluff, and overlies, stratigraphically, the lower or Camarocrinus fauna at that bluff, then the upper part of the Linden bed overlaps the lower part; suggesting the growth of the Cincinnati geanticline during the earlier part of the Paleodevonic. The studies so far made upon the Linden bed are insufficient to determine the matter.

No trace of the Upper Silurian or Cayugan has so far been discovered in the Tennessee River valley or in the Mississippi River basin.

From these observations it appears that the growth of the Cincinnati geanticline began in times preceding the Devonian, that its growth continued during early and middle Devonian times, and that it had reached considerable proportions in times preceding the deposition of the Chattanooga black shale.

The stratigraphic evidence secured so far is not sufficient to demonstrate the existence of the Cincinnati geanticline in Ordovician times. However, a study of the areal distribution of Silurian and Ordovician faunas suggests that the Cincinnati geanticline had its origin during Ordovician times, and that its effect upon the geographic range of faunas was considerable already during the earlier part of the Silurian[1] This method of determining the location of geologic barriers by means of a study of the distribution of faunas promises to be of the highest value, since it appears capable of demonstrating the existence and probable location of barriers even in cases where the stratigraphic evidence is defective, although, of course, it is eminently desirable that the results of paleontological research be corroborated by stratigraphical evidence.

Data are accumulating which suggest the existence of an elevation of land, or dome, in southwestern Tennessee during the later part of the Ordovician and at the beginning of the Silurian. According to the researches of Ulrich and Bassler, the Utica is absent in central and southern Tennessee; the Lorraine, however, is represented by equivalents of the Fairmount, Bellevue,

[1] ULRICH AND SCHUCHERT, "Paleozoic Seas and Barriers," *Report of New York Paleontologist* for 1901, No. 2.

and Corryville beds[1] of the Cincinnati section. The Utica is absent also in western Tennessee. The Swan Creek limestone is undoubtedly of Lorraine age; and analogy with the sections in central Tennessee, investigated by Ulrich and Bassler, suggests that the richly fossiliferous beds, containing *Platystrophia lynx*, below the Swan Creek limestone are probably equivalent to the Bellevue beds. No trace of the Fairmount, Bellevue, or Corryville beds has been recognized in western Tennessee, in the Tennessee River basin. This suggests a more rapid depression of the land eastward, permitting the invasion of the Lorraine sea, while in the Tennessee River basin no deposits belonging to the three horizons named are present. Moreover, the Richmond, although extending further southward and westward, is absent at Swallow Bluff, apparently also at Saltillo, and only a trace of Richmond clay, several inches thick, was found along Horse Creek, at Maddox mill. Again, the Clinton, which has a considerable development north, west, and southwest of Nashville, and which presents thick sections even as far south as Centreville and the Swan Creek valley, is less than 4 feet thick at Glenkirk, is 2 feet thick at Swallow Bluff, does not exceed 1 foot in thickness at Clifton, Riverside, and Iron City, is possibly represented by a few inches of decayed ferruginous material at the base of the Silurian section three miles northwest of Waynesboro, and possibly also by the more siliceous base of the Silurian section at the Maddox mill. Finally, the Osgood bed at Riverside is overlaid apparently unconformably by the Laurel, and south of Riverside and Clifton is either represented a much diminished section, not more than 3 feet thick, or cannot be differentiated as a distinct formation.

The identification of the Warren bed rests chiefly upon the presence of *Dinorthis retrorsa*. A variety of this fossil has recently been found in the upper third of the Lower Richmond or Waynesville bed, in Indiana, but it has fewer, coarser, and more distant radiating plications than the Warren bed form. However, the identification of a horizon should rest, not upon a single species,

[1] JOHN M. NICKLES, "Geology of Cincinnati," *Journal of Cincinnati Society of Natural History*, Vol. XX (1902), No. 2.

but upon the entire fauna. This will require further collecting. I desire here merely to call attention to the fact that even within the limited exposure at Clifton the supposed Warren bed runs out southward, and that this exposure also presents the thickest Richmond section so far discovered along the Tennessee River.

Recently Mr. Ray S. Bassler has identified *Hemiphragma imperfectum*, a characteristic species of the Upper Richmond in Illinois, from the coarse, cross-bedded ferruginous rock at the base of the Silurian section at Iron City. This necessitates also the reference of the cross-bedded, less ferruginous rock at the base of the Silurian section at Riverside to the Upper Richmond, the Clinton at both localities consisting of less than 1 foot of silicious or cherty limestone. The coarse conglomerate, half a mile east of Cedar Point at Iron City, is also probably of Upper Richmond age. While these rocks suggest deposition in shallow waters, and the probable vicinity of shore lines, their relation to a probable mass of elevated land toward the westward is unknown. The relation of this problematical mass of elevated land to the Nashville dome, as the southern half of the Cincinnati geanticline is sometimes called, also remains in doubt.

16. *As determined by observations in Ohio, Indiana, and Kentucky.* — In Ohio, Indiana, and Kentucky no unconformity has been noticed between any of the subdivisions of the Niagaran. The *Cayugan* is represented by a series of strata not sufficiently studied as yet to be divided into horizons. The *Salina* division is represented by the *Eurypterus* bearing beds at Kokomo, Indiana. In New York and adjacent Ontario these beds have been called the *Bertie or Lower Waterlime*. The *Manlius* division of the Cayugan is represented in part by the hydraulic limestone at Belleville, Sandusky county, Ohio, and the *Greenfield* limestone in the southern part of the state, as far as may be determined by the presence of *Orthothetes interstriatus* (*O. hydraulicus*), a fossil characteristic of the lowest or *Cobleskill* subdivision of the Manlius in New York, Pennsylvania, and Maryland. *Spirifer vanuxemi*, found on Put-in-Bay Island, Lake Erie, and *Leperditia alta*, identified at Bellevue, Sandusky county, Ohio, are characteristic of the *Manlius proper*, the upper member of the Manlius

division of the Cayugan of New York. Very little is known of the Cayugan in Ohio or Indiana beyond the fact that it is much thicker in the northern parts of these states and thins out southwards. It has not been detected south of the central part of Indiana, but in Ohio it it has been followed beyond Greenfield to the southern boundary of the state. It appears to cross the Ohio River into the northern part of the state of Kentucky. Recent observations suggest that the Cayugan (Greenfield or possibly Monroe) limestone of southern Ohio and northern Kentucky is unconformable to the Niagaran.

The Paleodevonic has not been recognized in Ohio, Indiana, or Kentucky. Various sandy beds have at different times been referred to the Oriskany, upon lithological rather than upon paleontological data.

The base of Mesodevonic is represented in central Indiana by the *Pendleton sandstone*, referred by Hall to the *Schoharie Grit.* The *Corniferous* or *Onondaga limestone* extends to the central part of the state of Kentucky, on both sides of the Cincinnati geanticline.[1] Indeed, in central Kentucky, the Corniferous is exposed at various points along the crest of the geanticline. East of the geanticline it extends as far south as the lower parts of Fishing Creek, west of Somerset. In Indiana and western Kentucky, the *Hamilton*, represented by the *Sellersburg* bed, is not known south of Louisville. In Ohio, on the eastern side of the geanticline, the Sandusky or Delaware limestone has been identified as the lower part of the Erian, and the Olentangy shales as the upper or Hamilton part. Neither of these beds has been identified south of the central part of the state. It does not reach the Ohio River, and certainly has not been seen in Kentucky.

There is no doubt about the presence of the Cincinnati geanticline in central Kentucky and in the neighboring parts of Indiana and Ohio, in times preceding the deposition of the Corniferous. The unconformity between the Corniferous and the various Niagaran and Ordovician strata is often very striking, con-

[1] CHARLES SCHUCHERT, "On the Faunal Provinces of the Middle Devonic of America." *Am. Geol.*, Vol. 32 (1903), No. 3.

sidering the comparatively small dips characterizing the strata along the Cincinnati geanticline. The absence of the entire Paleodevonic suggests the existence of a long period of no deposition between the Corniferous and Cayugan. During this time there may have been considerable erosion. Recent observations in southern Ohio and northern Kentucky, east of the geanticline, indicate the existence of a considerable unconformity between the Cayugan and the various subdivisions of the Niagaran. This suggests the origin of the northern part of the Cincinnati geanticline in times preceding the Cayugan. Observations are not yet sufficiently extended to lead to a definite conclusion.

There are indications of a rise of the sea bottom southward in Kentucky during the latter part of the Ordovician, accompanied by a slow sinking of sea bottom northward in Ohio and Indiana, but it has not yet been determined that these changes produced folding parallel to the Cincinnati geanticline. The absence of the entire Utica, of most of the upper Lorraine, and of all except the upper part of the Richmond, in Tennessee, suggests a relation between the facts observed in Kentucky and those discovered in Tennessee. The rise of the sea bottom appears to have begun much earlier in Tennessee than in central Kentucky, and to have been more pronounced in central Kentucky than in southern Ohio. It has, however, not been shown as yet that this elevation was more pronounced along the crest of the Cincinnati geanticline than on its flanks. The emphasis given to this lack of stratigraphic evidence at present may lead to future observations which may corroborate the deductions as to the very early origin of the geanticline, perhaps even in Ordovician times, based on paleontological data.

LOCALITIES MENTIONED IN THIS PAPER.

(Consult map on p. 30 of this volume.)

1. Paulk or Watson mill.
1*a*. Cave half a mile north of 1.
2. Junction of Turkey and Horse Creeks, a quarter of a mile above 1.
3. Iron bridge.
4. Lick Ford, at mouth of Willoughby Creek.

5. Willoughby Creek, above the mouth.
6. Welch or Maddox mill.
7. Dodds' mill.
8. Sulphur Spring, Ross and Arnold farms.
9. Calybeate Spring.
9*a*. Two hundred yards north of Calybeate Spring, north of mouth of branch.
10. Cab Blount.
10*a*. Pyburn Bluff, a mile and a half northeast of White Sulphur Spring.
10*b*. West slope of hill at store, White Sulphur Spring.
11. Cave Spring southeast of Cerro Gordo.
12. Cerro Gordo.
13. Saltillo.
14. Exposures along landing at Clifton.
14*a*. Hillside north of Waynesboro road, at eastern edge of Clifton.
14*b*. West of Eagle Creek, 3 miles from Clifton on road to Martin's mill.
14*c*. Three-quarters of a mile above the landing at Clifton.
14*d*. Swallow Bluff, on north side of river, half-way between mouths of Indian and Hardin Creeks.
14*e*. Bath Springs.
15. North of landing at Glenkirk, at mouth of Beech Creek; marked Dunkirk on the map.
15*a*. Short Creek, northeast of Lego, 300 yards southeast of W. E. Ashley and P. Denman.
15*b*. Along road leading east from New Era.
16. Glade southwest of Brownsport Furnace, 3 miles west of Vice Landing.
17. Glade northwest of Charles McClanahan's home, 2 miles west of Vice store.
18. Mound glade, ¼ mile north of Vice store, on Perryville road.
19. Mound glade, ½ mile west of 18.
19*a*. Series of glades southwest of Dixon Spring.
20. Northwest edge of Perryville.
21. Quarry northeast of Perryville, on Tennessee River.
22. William H. Patten, one mile north of Linden, at spring north of house.
22*a*. Exposure in woods at bluff northeast of 22.
23. East of William Goodwin, Coon Creek, 2.2 miles east of Linden.
24. Spring northeast of J. M. Goodwin, farther up Coon Creek.
25. Spring, eastern edge of Linden.
26. Quarter of a mile west of J. S. Journey, Short Creek, 1 mile east of Linden.
27. E. Duncan, 1.5 miles east of Linden, at mouth of Jacks branch of Short Creek.
28. Webb or Rise mill.
28*a*. Tate hollow, half a mile from Buffalo River, at forks of road, 3 miles south of Linden.

29. North of railroad bridge, northwest of Riverside.
29*a*. At station, Iron City.
29*b*. At Cedar Point, a mile north of station at Iron City, on west side of railroad to Pinckney.
30. Northeast of mouth of Trace Creek, west of Riverside.
31. Bluff on Buffalo River, east of Ezekial Cothran, 2 miles southwest of 30.
32. South of Ed. Walker, east side of Tucker Branch.
33. Road crossing over Carter Creek.
34. South of Old Mill on Mill Creek.
35. Between Big Opossum and Hope Creeks.
36. Half a mile west of Dr. Evans, west of Hope Creek.
37. Northwest of Flat Woods, at mouth of Little Opossum Creek.
38. John Henry Johnson, along Waynesboro road, 7 miles east of Savannah.
39. East of George Wilson, 7.5 miles east of Savannah.
39*a*. East of Jim Irwin, 8 miles east of Savannah.
40. Old Colonel Jim Smith place, 9 miles east of Savannah; John Goodwin farm, 4 miles east of Economy.
41. Southeast of W. D. Helton on Beech Creek, 3.5 miles northwest of Waynesboro.
42. Six miles west of Waynesboro, at crossing of Martin's mill road over Brewer Branch.
43. West of Dr. Yeiser, 6 miles east of Martin's mill.
44. Hillside northeast of stables on Gant Place.
45. Half a mile north of Martin's mill on north side of Indian Creek, opposite site of Craven's mill.
46. Hillside at north end of Martin's mill.
47. A mile and a half northwest of Martin's mill, on north side of Indian Creek.
48. Half a mile west of 47, where road ascends the hill.
49. Four miles northwest of Martin's mill, on south side of Indian Creek, south of the home of Mr. Phillips.
100. Whirl of Buffalo River, 5 miles by road north of Bakerville.
101. Along railroad, northwest of John Broadus.
102. Hillside east of John Broadus.
103. Northwest of Dr. W. B. Scott.
104. Half a mile west of Cumberland City, along the river.
105. Christopher Schmidt, hill slope south of house, about 2 miles west of John Broadus.

WELLS (UPPER STONES RIVER) FOSSILS.

The fossils here listed were obtained about a mile and a quarter southwest of Cumberland City, along the railroad, about half a mile south of the crossing of the Erin pike:

Illaenus; glabellae slightly resembling *I. americanus*, but not accompanied by the characteristic pygidia of that species; probably identical with the forms listed by Safford from the Glade limestone as I. americanus.

Maclurea bigsbyi.

Crania; related to *setigera*, but with the surface of the upper valve crowded with minute pustules which may have been the bases of setae.

Orthis tricenaria.

Dinorthis deflecta.

Dalmanella subaequata, variety.

Strophomena incurvata (*filitexta*).

Rafinesquina minnesotensis (*incrassata* of Safford).

Plectambonites sericea.

Hallina nicolleti?

Zygospira recurvirostris.

Rhynchotrema related to *inaequivalvis*, but with a more triangular outline, and with the sides more flattened, producing a more angular shell; probably identical with *Rh. orientalis* of Safford.

Helopora spiniformis, identified by R. S. Bassler.

SALTILLO (LOWER TRENTON) FOSSILS.

Whiteavesia, identified by R. S. Bassler as identical with a species found in the Lower Trenton in Central Tennessee; W. D. Helton locality.

Leptobolus, resembling *insignis*, Clifton.

Trematis punctistriata, Clifton.

Schizocrania (*?*) *rudis*, Clifton.

Schizocrania, related to *filosa*, Clifton.

Lingula, Clifton.

Dalmanella, apparently an ancestral form of *D. emacerata* from the Utica group of the Cincinnati region; some of the specimens are 18 mm long and 28 mm wide, but usually the dimensions are 16 by 21. When compared with Utica specimens which have not been crushed flat, the similarity is striking. W. D. Helton, Clifton, Wells creek basin.

Zygospira modesta, with the four median plications of the ventral valve forming a distinct fold, the slightly more distinct median groove separating these plications into pairs; Clifton.

CLINTON FOSSILS.

Illaenus daytonensis, glabellae and *pygidia*; 14, 15, 29*b*.

Illaenus, pygidia resembling *madisonianus*, but with a less triangular outline; found in Clinton of Ohio and Indiana, 14*d*, 29.

Calymmene vogdesi, pygidia and *glabellae*; 14, 14*d*.

Lichas breviceps clintonensis, glabellae and pygidia; 14.

Cyrtoceras (*Glyptoceras*) *subcompressum*, showing surface marking and siphuncle; 14.

Orthoceras ignotum, showing smooth surface; 14.

Cyclonema daytonensis (published as *C. bilix* in Vol. VII, *Ohio Survey*, Pl. 30, Fig. 15; see also *Twenty-fourth Annual Report of Indiana Survey for 1899*, p. 77); 14.

Diaphorostoma (*Platyostoma*) *niagarense*; 14.

Cypricardinia related to *undulostriata*, found also in Ohio (*Ohio Survey*, Vol. VII, Pl. 47, Fig. 9); 14.

Orthis flabellites; 14.

Platystrophia daytonensis; 14.

Dalmanella elegantula; 14, 14*d*.

Triplecia ortoni; 14, 29*b*.

Leptaena rhomboidalis; 14, 14*d*, 29*b*.

Plectambonites transversalis elegantula; 14.

Stricklandinia (*?*) *dichotoma*; generic affinities uncertain, the interior being unknown; valve moderately convex, 23^{mm} long, 30^{mm} wide, marked by about 20 plications on the posterior half of the shell, of which all except the posterolateral ones branch once dichotomously on the interior half of the shell, crossed by very fine concentric striæ; 14, 29, 29*b*.

Pentameroid shell of unknown generic affinities; valves nearly equal, the beak of the ventral valve extending slightly beyond that of the dorsal valve; the interior of the ventral valve apparently supplied with a short septum supporting a very small spondylium; the interior of the dorsal valve does not show two parallel septa; form oblong; length 35^{mm}; width 28^{mm}; thickness 16^{mm}; valves with low, broad, radiating plications which increase in number anteriorly both by dichotomous branching and by intercalation, those along the center of the valve often raised on an almost imperceptible fold; 29, 29*b*.

Atrypa marginalis; 14*d*.

Favosites favosus; 14, 29.

Favosites niagarensis; 14.

Halysites catenulatus; 14, 29.

WALDRON FOSSILS.

Hyolithes newsomensis; length 25^{mm}, the convex side sharply striated longitudinally, the more prominent striæ being separated by 4 to 8 finer ones; the flat side nearly smooth; 14*d*, 29*a*.

Orthoceras amycus; 14*c*, 14*d*, 29*a*, 29*b*.

Orthoceras simulator; 14*c*, 14*d*.

Diaphorostoma niagarense; 15*b*, 29*a*.

Cypricardinia arata; 14*d*, 15*b*.

Dictyonolla reticulata; 14*d*, 15*b*.

Meristina maria; 14*c*, 14*d*, 15*b*, 29*b*.

Homoeospira evax; 14*c*, 14*d*, 15*b*, 29*a*, 29*b*.

Homoeospira sebrina; 29*a*.

Homoeospira, more convex than *sobrina*; found also at Newsom, 29*a*.
Whitfieldella nitida; minute, 15*b*.
Nucleospira pisiformis; 14*d*, 15*b*, 29*a*, 29*b*.
Spirifer swallowensis; resembling *crispatus*, but with only one well developed lateral fold on each side; 14*d*.
Spirifer eudora; 29*b*.
Reticularia petila; 14*d*, 15*b*.
Atrypa reticularis newsomensis; 14*d*, 15*b*, 29*a*, 29*b*.
Atrypina disparilis; 14*d*, 29*a*, 29*b*.
Anastrophia internascens; 14*c*, 14*d*, 15*b*, 29*a*, 29*b*.
Plectambonites tennesseensis; width 7–9^{mm}; convex valve with about 5 striæ, which are conspicuously stronger than the remainder, partly due to radiate plication; form as in *transversalis*; 14*c*, 14*d*, 15*b*, 29*a*, 29*b*; found also at Newsom.
Leptaena rhomboidalis; 14*c*, 14*d*.
Rhipidomella hybrida; 14*c*, 14*d*, 15*b*, 29*a*.
Dalmanella elegantula; 14*d*, 29*a*, 29*b*.
Macrostylocrinus striatus; 29*a*.
Lecanocrinus pusillus; 29*a*.
Eucalyptocrinus magnus; 14*c*.
Eucalyptocrinus elrodi; 14*c*.
Stephanocrinus gemmiformis; 14*c*, 14*d*, 29*a*, 29*b*.
Stephanocrinis tennesseensis; body approximately inversely conical, the sides diverging at angles varying from 50 to 60 degrees; constriction at base usually slight; base usually sharply pointed and triangular in cross-section; some specimens less acute, much larger than *gemmiformis* from the same beds; length to base of ambulacral grooves 6.5 to 7.5^{mm}, length of interambulacral projections of the body 2^{mm}; 14*c*, 14*d*, 15*b*, 29*a*.
Callopora elegantula; 14*d*, 29*a*.
Streptolasma radicans; 29*a*.
Astylospongia praemorsa pusilla; 14*d*.

BROWNSPORT FOSSILS.

Acidaspis, 1 species; spiny pygidium only; 46.
Calymmene niagarensis; 14*a*, 16. Gant bed at 46, Pegram, 14*eC*.
Ceraurus niagarensis; was found by Roemer in vicinity of Dixon Spring.
Dalmanites, 1 species; large, related to *D. verrucosus*; head 15, pygidium 16.
Encrinurus, 1 species; small pygidia; 14*a*, 35 Pegram.
Illaenus, 1 species; pygidia broad as in *I. armatus*; 14*a*, 15, 19*a*.
Phacops, 1 species; Gant bed 46.
Sphaerexochus romingeri; glabellae; 14*a*, 15, 14*eA*.
Amphicoelia ?, 1 species; large; 10 radiating plications in a width of 10^{mm}, 6^{cm} from the beak; 21.

Cypricardinia, 1 species; Gant bed 46.

Cypricardinia?, 1 species; small, related to *C. Caswelli*; 18.

Pterinea, 1 species; 16.

Cyclonema tennesseensis; not identified; type specimens found within several miles of Dixon Spring; 19*a*.

Holopea, 1 species; cast, 46.

Platyceras niagarense; 14*a*, 19*a*, 49.

Platyceras, brownsportensis vertically compressed at margin, more than in *Pl. sinuatum*; 12, 16, 14*eC*.

Diaphorostoma (*Platyostoma*) *niagarense*; 14*a*, 15, 16, 19*a*, 46, 49, 14*eA*, 14*eC*, 40.

Platyostoma, 1 species; general aspect that of a *Cyclonema*; 12, 16, 18.

Dictyonella gibbosa; Gant bed, 44, 46, 47; described by Hall from Perry county.

Dictyonella concinna; described by Hall from Perry county.

Dioryonella reticulata, 40.

Meristina maria roemeri; 15, 16, 19, 46, Pegram, 40.

Merista tennesseensis; 12, 16, 19, Gant bed 46, 14*eA*, 14*eC*, 39, 40.

Trematospira simplex; largest specimens 18^{mm} long; common at 12, 16, 14*eC*, 40.

Trematospira, 1 species; 6^{mm} long, with general outline and form of *T. tennesseensis*, but much smaller; Gant bed 44.

Homoeospira schucherti; largest specimen 13^{mm} in length, both valves with narrow median depression occupied by 1 or 2 narrow plications; type from Brownsport, 12, top 16, 18, 19, 44, 46, 47, 14*eA*, 14*eC*, 39, 40.

Homoeospira sobrina (?); 14*eC*, 38, 40.

Homoeospira beecheri; largest specimen 8^{mm} in length; shallow depression of ventral valve occupied by 2 plications slightly smaller than the rest; bottom of median furrow of dorsal valve occupied anteriorly by 2 narrow striæ, which are the bifurcated top of a low plication easily overlooked; type from Brownsport, 16.

Anoplotheca (*Coelospira*) *saffordi*; length 5^{mm}; ventral valve strongly convex, with 3 plications forming an indistinct median elevation, and with 3 distinct and 1 or 2 indistinct plications on each side; dorsal valve concave, especially anteriorly along the shallow median depression; depression occupied by 2 plications close together, more widely separated from the neighboring plications; Gant bed at 44, 14*eC*, 39.

Nucleospira concentrica; Gant bed, 44, 47; type from Decatur county, quoted by Whitfield and Hovey from Meniscus beds of Decatur county, and by Safford from Bath Springs in Decatur county; 14*eA*, 14*eC*, 39, 40.

Nucleospira, 1 species; probably *pisiformis*; 14, Gant bed 44, 14*eA*.

Cyrtia cliftonensis; height of cardinal area 6^{mm}, width 10^{mm}; margins of sinus of ventral valve distinct and angular, diverging at an angle of 52°, resembling *C. meta*; 14*a*.

Reticularia pegramensis; length 15^{mm}, width 19^{mm}; median fold low, but distinct, 5^{mm} broad anteriorly; median depression shallow; no lateral plications; concentric lines of growth distinct; found only at Pegram.

Delthyris, 1 species; 8^{mm} long, 10.5^{mm} wide; median plication of dorsal valve with faint depression along the axis anteriorly; 3 distinct and 1 indistinct plication on each side; cardinal angles acute; surface ornamentation similar to that of *Spirifer crispus*; 12, 16.

Spirifer oligoptychus; the radiating striæ are coarser than in *Sp. eudora* from the Waldron bed, and are not crenulated by transverse lines of growth, 14*a*, 19*a*.

Spirifer geronticus; 20^{mm} long; median fold and sinus distinct; 1 or 2 on each side at the beak, usually disappearing within 7^{mm} from the beak; radiating striæ; type from Dixon Spring; 14*a*, 19*a*, 49, Pegram.

Spirifer foggi; 14*a*, 19*a*, Pegram.

Spirifer saffordi; surface ornamented as in *Sp. crispus*, but the concentric striæ are much more distinct; cited by Whitfield and Hovey from the Meniscus beds of Perry county, Tenn., and by Safford from the Gant locality in Wayne county, and Bath Springs in Decatur county, formerly a part of Perry county, Gant bed 44.

Spirifer crispus; 12, 16, 19*a*, 40.

Spirifer crispus variety; concentric striæ finer and closer together; shell slightly narrower; 12, 16, 14*eC*.

Atrypa reticularis newsomensis; types from Waldron bed at Newsom, Tenn., 8 or 9 plications in a width of 10^{mm}; 16, 19, Pegram, 14*eC*, 39, 40.

Atrypa reticularis niagarensis; 12 to 14 plications in a width of 10^{mm}; 14*a*, 16, 19, 19*a*, 49, 103, Pegram, 14*eA*.

Atrypa reticularis arctostriatus; 28 plications in a width of 10^{mm}; top at 16.

Atrypa marginalis; 14*a*, 15, 16, 18, 19*a*, 49; similar forms included by Nettelroth under *C. Calvini*; 14*eA*.

Atrypina, 1 species; 16, 19*a*, 21.

Uncinulus stricklandi; 12, 16, 21, 43, 46, Gant bed 45, 46, 14*eC*, 40, 15*a*.

Uncinulus tennesseensis; shell smaller than *stricklandi*, usually with fold and sinus more distinct; 12, 14*a*, 16, 19, 19*a*, 20, Gant bed 46, Pegram, 14*eC*, 40.

Rhynchonella lindenensis; outline roughly circular; with three plications on fold, 2 in sinus, and 8 or 9 on each side; at 27 near Linden. A similar shell with only 6 or 7 plications on each side occurs at 16 near Brownsport Furnace; interiors unknown.

Wilsonia saffordi; 14*a*, 15, 16, 19, 19*a*, 49, 103, Gant bed 44, 46, 14*eA*, 14*eC*, 39, 40.

Camarotoechia; similar in form to *C. neglecta*, but 12^{mm} long and with the surface apparently smooth; 12, 16, 19, 19*a*, 27, Gant bed 46, 14*eC*, 38, 40.

Cāmarotoechia; cuneate in form, 11^{mm} long; sinus and fold almost imperceptible except on direct anterior face of shell; 12, 16.

Gypidula roemeri; 14*a*, 16, 18, 34, Gant bed 46, 14*eC*, 39, 40, 15*a*.

Conchidium littoni; described from Hardin county; identified by Safford from the Meniscus horizon.

Conchidium legoensis; length, 29 to 31^{mm}; width, 20 to 24^{mm}; thickness, 16 to 17^{mm}; 12 to 14 radiating plications; related to *C. crassiplica*; 15*a*.

Conchidium lindenensis; in form and frequency of radiating plications most nearly resembling *C. colleti*, but without frequent lines of growth, and only 50^{mm} long; not rare within 10 feet of base of section, east of house of William Goodwin on Coon Creek, opposite road leading off to Linden; 23.

Plectambonites, 1 species; Gant bed 44.

Strophonella roemeri; profile resembling Fig. 4*c*, Plate 23, Vol. III, *N. Y. Pal.*; striæ very fine and numerous in umbonal region, every fifth or sixth one distinctly more prominent; the more prominent striæ become more numerous in the pallial region, 12 to 15 in a width of 10^{mm}; length 43^{mm}, width 60^{mm}, outline triangular; about 35 feet above base of Dixon bed at Brownsport Furnace, 16; Gant bed 46; 12, New Era.

Strophonella prolongata; width 31^{mm}, length 15^{mm}; plications 18 to 21 in a width of 10^{mm} along anterior margin, numerous at beak; profile as in Fig. 6*c*, Plate 23, Vol. III, *N. Y. Pal.*; 16, 19*a*, Gant bed 44, 46, 39.

Strophonella laxiplicatus; plications consist of sharp narrow ridges separated by comparatively wide spaces, new plications are added along the middle of these spaces. Comparatively few plications (usually less than 10) begin at the beak. Related to *Str. semifasciata*, but plications more numerous, more prominent, and shell much smaller; 16, 12, 14*eC*, 39.

Leptaena rhomboidalis; 16, 14*a*, Gant bed, 46, 14*eC*, 39.

Orthothetes subplanus; 12, 16, 14*eA*, 14*eC*, 40.

Orthothetes roemeri; plications fewer, separated by wider spaces; shell much smaller; 19*a*, Pegram.

Dalmanella fissiplica; 19*a*, 14*a*, 36, 49, 103, 14*eA*.

Dalmanella elegantula; only 11^{mm} long, otherwise typical; 14*a*, 19*a*, 35. Larger form with usually finer striae, 20^{mm} long; top at 16, 14*eC*, 39, 40.

Dalmanella arcuaria; 14*a*, 15, 16, 18, 46, 49, 103.

Rhipidomella lenticularis; resembles *Rh. circulus*, but the striæ are much more numerous, largest specimens 28^{mm} long; top at 16.

Rhipidomella hybrida; variety, 12^{mm} long; 14*eC*, 38, 39, 40.

Rhipidomella saffordi; length 8^{mm}, dorsal valve strongly convex, but indented along the middle by a distinct depression which begins at the beak and is widest and deepest at the anterior margin; Gant bed 44, Pegram, 14*eC*, 39.

Bilobites biloba; 14*a*, 19*a*.

Allocrinus typus; Clifton and Decatur counties.

Callicrinus (*Eucalyptocrinus*) *ramifer*; Wayne and Decatur counties.

Caryocrinus ornatus; 14*a*, 16, 19*a*, 49.

Caryocrinus bulbulus; Wayne county.
Caryocrinus milliganae; Decatur county.
Centrocrinus tennesseensis; Clifton.
Coccocrinus bacca; 49.
Cystocrinus tennesseensis; a parasitic growth on a crinoid stem; 14*a*, 19*a*, 20.
Eucalyptocrinus ventricosus (= *E. caelatus* of Roemer); Decatur, Wayne and Perry counties; 14*eA*.
Eucalyptocrinus milliganae; Decatur county.
Eucalyptocrinus lindahli (= *wortheni* of Miller); Wayne county.
Gazacrinus tennesseensis; Tennessee, locality unknown.
Glyptaster milliganae; Decatur county.
Idiocrinus tennesseensis; Clifton.
Lampterocrinus tennesseensis; 15, 19*a*, 20, 49.
Lecanocrinus pisiformis (*Poteriocrinus*); 19*a*, 18, 49, 46, 39.
Lecanocrinus. 1 species; identified by Springer as a form found at St. Paul Indiana; 21.
Lecanocrinus pusillus; 16.
Marsupiocrinus striatus; Decatur county.
Marsupiocrinus (*Platycrinus*) tennesseensis; 14*a*, 16, 19*a*, 49.
Melocrinus (*Mariacrinus*) *nobillisimus*; cited as occurring apparently in the Niagara of western Tennessee.
Melocrinus (*Cytocrinus*) *roemeri* (= *laevis*); 46. This may be *Actinocrinus verneuli* of Troost.
Myelodactytus gorbyi; cited from Tennessee.
Periechocrinus tennesseensis (= *Saccocrinus speciosus* of Roemer); 14*a*.
Pisocrinus campana; 15, 14*a*, 19*a*, 46, 49.
Pisocrinus gemmiformis; 14*a*, 19*a*, 35, 39.
Pisocrinus milligani (= *gorbyi*); 14*a*, 15, 19*a*, 46, 49, 38.
Pisocrinus (*Synbathocrinus*) *tennesseensis*; 14*a*, 19*a*, 49.
Taxocriuus; genus identified by Springer, 14*a*.
Thalamocrinus ovatus; Decatur county.
Thalamocrinus cylindricus; Decatur county.
Thysanocrinus milliganae; Decatur county.
Troostocrinus (*Pentatrematites*) *reinwardti*; 15, 16, 18, 19*a*, 49, 14*eA*.
Zophocrinus howardi; 14*a*.
Callopora elegantula; 16, 19, 12, 14*eC*, 39, 40.
Fistulipora (*Thecostegites*) *hemispherica*; 14*a*, 16, 32, 34, 35, 42, in Brownsport bed; abundant also in Dixon bed, 14*eA*, 14*eC*, 14*eE*, 39.
Alveolites niagarensis; 27.
Amplexus shumardi; 14*a*, 16, 27, 46, 38, 39*a*.
Anisophyllum; listed as An. agassizi by Prof. Safford, 14*eC*, 39.
Aulopora roemeri (= *repens* of Roemer); 27.
Calceola tennesseensis; 14*a*, 15, 16, 27, Pegram.
Cladopora complanata; 27.

Cladopora reticulata; 27.

Coenites verticillata; 27.

Ditoecholasma (Petraia) fanningana; 14*a*, 15, 16, 19*a*, 49, 14*eC*, 39*a*.

Enterolasma (Petraia) waynense; 14*a*, 16, 19*a*, 46, 49, 36, 14*eA*, 14*eC*, 14*eE*.

Eridophyllum proliferum; related to *E. sentum*, but corallites free, not connected laterally; the calyx of mature specimens not often seen, because usually filled by young corallets, invariably 4 corallets in each calyx; 16. 27, 39*a*.

Favosites cristatus; 14*a*, 15, 16, 27, 46, 14*eC*, 40.

Favosites cristatus major; 14*a*, 27, 46, 49.

Favosites discoidea; 14*a*, 16, 19*a* 32, 35, 49, Pegram, 14*eC*.

Favosites discus; 27, top of 16.

Favosites favosus; 16, 15, Pegram.

Favosites niagarensis; 27, 39*a*.

Favosites spongilla; 16, 27.

Favosites obpyriformis; growth globose or inversely pear-shaped, 12^{cm} in height; corallites 3 to 4^{mm} in diameter; 17.

Halysites catenulatus; 27.

Heliolites subtubulatus; 27, 16, 103.

Omphyma verrucosa; 16.

Laccophyllum acuminatum; Perry county, 14*a*, 16, 39*a*.

Plasmopora follis; 16, 27, 103, 38, 39*a*.

Platyaxum platys; corallum forming flat, very thin (1 to 3^{mm}) fronds, which are irregularly lobate; corallites very oblique; apertures sinuate, central part elevated, the sides adnate to the frond; probably congeneric with Alveolites; 15 corallites in a with of 10^{mm}; 16, 27.

Striatopora; related to Str. *flexuosa*; 12, 14*a*, 19, 19*a*, 16.

Thecia major; 14*a*, 27, 39*a*

Thecia swindernana; 15, 16, 27.

Ptychophyllum vulcanius; coral 65^{mm} wide, thin at the edges, 4^{mm} thick 17^{mm} from the center, maximum height 15^{mm} at 6^{mm} from the center, about 10^{mm} at the center. Top of coral flat; the base is not preserved, but, judging from what remains, its sides once spread at an angle of more than 45°, until it reached a diameter of about 35^{mm}, and then it spread almost horizontally. A basal view suggests the appearance of a model of a low volcano, with a distinct crater at the center. The septæ from this side have a striking resemblance to those forming the calyx in *Ptychophyllum ipomoea*; 36.

Astraeospongia meniscus; 14*a*, 14*b*, 22, 20, 35, 37, 43, 44, 46, 49, 102, 103, 14*eA*, 15*b*.

Anomoclomella zitteli; Decatur county.

Astylomanon cratera (Palaeomanon); figured by Roemer in his monograph of West Tennessee fossils on Plate 1; to Figs. 4 and 4*a* must be added also Figs. 1 and 1*a* on the same plate, according to Rauff. The following

varieties are established: *prototypum, aryballium, balantium, lecythium, promiscua, poterium, cantharium, cylix* which is the typical form, *patera*; 14*a*, 15, 19*a*, 28*a*, 103, 14*eA*.

Astylomanon pluriexcavatum; Decatur county.

Astylomanon verrucosum; figured by Roemer as *Astylospongia praemorsa* on Plate 1, Figs. 1*b*, 1*c*; 14*a*, 15, 16, 19*a*, 46, 103, Gant bed 46, 14*eA*, 39, 39*a*.

Astylomanon verrucosum bulbifera; Decatur county.

Carpomanon glandulosum; Decatur county.

Caryomanon roemeri; western Tennessee.

Caryomanon inciso-lobatum; 14*a*, 16, 46, 47, Gant bed 46, 14*eA*, 14*eC*.

Caryomanon stellatim-sulcatum; 14*a*, 15, 16, 19*a*, 22, 46, 49, 14*b*, 103, Gant bed 46, 14*eA*, 14*eE*, 38, 15*b*.

Caryomanon stellatim-sulcatum distorta; Decatur county.

Chiastoclonella headi; Decatur county.

Dendroclonella rugosa; Perry county.

Hindia sphaeroidalis (*Calamopora fibrosa* of Roemer); 14*a*, 15, 16, 27, 103, 14*eA*, 38.

Pycnopegma pileum; Decatur county.

Pycnopegma callosum; Decatur county.

Pycnopegma stromatoporoides; Decatur county.

Astylospongia imbricato-articulata; 14*a*, 15, 16, 46, 14*eA*.

LINDEN (HELDERBERGIAN) FOSSILS.

Favosites conicus; 10*a*, 10*b*, 21.

Favosites, with convex base covered by the epitheca; 9*a*, 10*a*, 10*b*, 21.

Pleurodictyum lenticulare; 10*a*, 10*b*, 21.

Striatopora issa; 21.

Brachiocrinus; 21.

Camarocrinus saffordi; 9*a*, 10*a*, 104.

Bilobites varica; 9*a*.

Dalmanites subcarinata, with coarse striæ; 9*a*, 10*b*, 21.

Dalmanites subcarinata, with fine striæ; 9*a*, 21.

Hebertella; 21.

Rhipidomella emarginata; 21.

Rhipidomella oblata; 9*a*, 10*a*, 10*b*, 21.

Orthothetes woolworthanus; 10*a*, 10*b*, 21, 22.

Leptaena rhomboidalis; 9*a*, 10*a*, 21.

Stropheodonta beckei; 10*a*, 10*b*, 21.

Strophonella punctulifera; 9*a*, 10*a*, 21, 104.

Chonostrophia, related to *Helderbergia*, but wider in proportion to length; 23^{mm} wide, 11^{mm} long; 10*a*.

Gypidula, without fold or sinus, plications narrow (as in Figs. 9–12, Plate 28, *The Paleozoic Fauna*, New Jersey Survey, 1903), but more obsolete towards beak and sides; 21, 104.

Uncinulus nucleolatus; 10*a*, 10*b*, 21, 104.

Uncinulus, with 2, occasionally with 4, plications on mesial fold, and 3 or 4 lateral plications; largest specimen 11^{mm} long, 11^{mm} wide, 10^{mm} thick, angular; 10*b*, 21.

Uncinulus, related to *vellicatus*, but smaller; the mesial fold only slightly elevated; ventral valve flattened toward the lateral margins and then abruptly bent toward the suture; 10*b*.

Uncinulus schucherti, resembling *Wilsonia saffordi*, but that part of the ventral valve occupying the fold projects far less beyond the lateral margins of the shell; the dorsal valve is more evenly convex; the anterior face of the shell is not flattened, so that a lateral view is less angular; plications on mesial fold vary from 4–5; of the lateral plications 7–10 are distinct, and 2–4 indistinct; largest specimen 15^{mm} long; globular or moderately elongated; 10*a*, 10*b*, 21.

Rhynchonella transversa; 10*b*, 21.

Rhynchonella bialveata; 21.

Rhynchotreta; cuneate triangular form without distinct sinus or fold; 21.

Atrypa reticularis; 10*a*, 10*b*, 21.

Cyrtina dalmani; 21.

Delthyris perlamellosus; 9*a*, 10*a*, 10*b*, 21, 22, 104.

Delthyris, related to *perlamellosus*, but with flat, high, triangular on ventral valve, giving the shell a slight resemblance to a *Cyrtina*; 10*a*, 10*b*, 21.

Spirifer cyclopterus; 10*a*, 10*b*, 22, 104.

Spirifer, with radiate striæ and 3 or 4 lateral plications; possibly identical with *Sp. tenuistriatus*, the horizon of that species not being definitely known; 10*a*.

Nucleospira; flatter than in *ventricosa*; 10*b*, 21.

Lissopleura; smooth, oblong, quadrangular form; 21.

Anoplotheca concava; 21.

Rhynchospira globosa; 10*b*, 21.

Rhynchospira formosa; 10*b*, 21, 22, 104.

Meristella Meeki; 10*a*, 10*b*, 21, 22, 104.

Meristella; related to *princeps*; 9*a*, 10*a*, 21, 104.

Platyceras tenuiliratum; 10*a*, 21.

Dalmanites pleuroptyx; 10*a*, 10*b*, 21.

Phacops logani; 10*a*.

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